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THE STUDY OF AIR LEAKAGE ACROSS LONGWALL WASTES

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THE STUDY OF AIR LEAKAGE ACROSS LONGWALL WASTES

by

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SUMMARY

In response to a request by the Cape Breton Development Corporation, the CANMET Coal Research Laboratory in Sydney has produced a proposal for the study of air leakage across longwall wastes.

This proposal consists of two approaches; a geotechnical approach aimed at monitoring the behaviour of the gateroad and the surrounding strata, and a ventilation science approach aimed at identifying leakage pathways through the waste, and determining the effectiveness of remedial measures.

Results from both experimental approaches will be used to suggest the most effective methods of controlling air leakage across longwall wastes.

It is stressed that the proposal involves substantial cost on the part of the CBCRL and that active, continuous and irreversible support is required from CBDC in order to justify the expenses involved and to maximize the information obtained.

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ÉTUDE SUR LES FUITES D'AIR DANS LES VIEUX TRAVAUX DES EXPLOITATIONS PAR LONGUES TAILLES

par

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SOMMAIRE

À la demande de la Société de développement du Cap-Breton, le Laboratoire de recherche sur le charbon de CANMET, à Sidney, a préparé une proposition d'étude sur les fuites d'air dans les vieux travaux des exploitations par longues tailles.

Cette proposition comprend deux volets: une étude géotechnique visant à contrôler le comportement des voies de roulage et des couches environnantes et un examen de la ventilation afin de déterminer le cheminement de l'air à travers les vieux travaux et l'efficacité des mesures correctives.

C'est à partir des résultats de ces deux expériences que seront choisis les meilleures méthodes de contrôle des fuites d'air dans les vieux travaux des exploitations par longues taille.

Il faut souligner que la réalisation de cette étude entraînera d'importants déboursés pour le LRC et que la SDCB devra fournir un soutien actif et permanent afin de justifier de telles dépenses et d'obtenir le maximum de renseignements.

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INTRODUCTION

Recent discussions between CBDC and CBCRL have reaffirmed the problem of air leakage across longwall wastes as a major research priority in the short and medium term.

Leakage of air from the maingate, across the waste and into the return can be a serious problem on the advancing longwall coalfaces at Lingan and No. 26 Collieries. In one instance, 70 percent of intake air was lost before it reached the coalface (1). It is currently assumed that leakage occurs through the pack and through mining induced fractures in the strata around the gateroad, and there is some evidence to suggest that sandstone channels in the immediate roof localize major leakage paths.

Several approaches to solving this problem have been tried in the Sydney Coalfield. The use of 'Aquapak', urea-formaldehyde foams and shotcrete as gateroad or pack sealants have proved partially successful, but application difficulties, high costs and the partial success rate indicate the need to investigate alternative solutions. Perhaps the most successful method of preventing gob leakage yet implemented is that of 'cundy' style ventilation, (Fig. 1). The implementation of this method, however, is dependent on the cessation of working in the longwall to be used as a return prior to the need for a 'cundy' in the down-dip wall. Future production schedules may not allow these conditions to be met; hence, the need for an alternative solution to the problem.

In order to assist CBDC in their search for an answer to gob leakage, CBCRL have been asked to design a research programme with the following aims:

1) The identification of leakage pathways and their relationship to geological and mining features;
2) The determination of the behaviour of gateside packs, and its relationship to the formation of leakage pathways. (In addition, this aspect will provide design criteria should radical changes in support design be required);

3) The determination of remedial measures required to reduce the air leakage; and

4) The monitoring of remedial measures selected to verify their performance.

These aims will be served by approaching the problem in two ways. Ventilation Scientists from CBCRL and CBDC will use tracer gas techniques to identify leakage pathways, and a geotechnical research programme will be implemented to evaluate the effect of pack behaviour on the formation of leakage pathways.

The determination of remedial measures will be greatly assisted by the report of a contract entitled 'Gateroad Sealants to Control Gob Leakage' (2), to be completed by April 1984.

GEOTECHNICAL INVESTIGATIONS

These geotechnical investigations are intended to complement parallel tracer gas studies by providing details of the performance of the gateside pack. Pack performance affects the degree of deformation in the gateroad, and hence the development of mining induced fractures through which air may leak into the gob. The investigations proposed will provide details of pack behaviour and the development of yield zones around the gateroad, which may be related to the formation and extent of leakage paths. They will also provide design data for the modification of pack systems, should this be necessary to control the leakage problem.

The proposed investigations are similar in form to those outlined previously for the investigation of gateroad deformation at Lingan Colliery (3), with minor modifications brought about by improved instrumentation.

INVESTIGATION DESIGN

The investigation design has been chosen to fulfill the following requirements:

a) to provide enough information to allow an accurate assessment of the behaviour of gateside packs;

b) to enable the investigation results to be compared effectively with results from similar sites in different geological conditions in the same, or other, gateroads; and

c) to provide pack design criteria for use if pack design changes are considered necessary.

This is accomplished by including four concurrent stages in the investigation package, each of which is described below.

Instrumentation

The parameters to be monitored and the corresponding instruments to be used are as follows:

- Differential strata movement around the gateroad	Point anchored Strata bolts/Extensometer
- Convergence and roadway profile deformation	Strata bolts/tape and offset/photography
- Pack closure	Pack struts
- Pack stress	Flat jacks

Point anchored strata bolts - Standard strata bolts, cut or extended to the desired length, are installed around the gateroad in the roof, sides and floor. The bolts are anchored by quick setting resin or mechanical means at the distal end, the movement at this point being represented by the movement of the free end.

By survey levelling from the bolts to a reference station in a more stable area of the roadway, differential strata movement and the relative contributions of floor heave and roof lowering can be calculated. Short strata bolts or stations on the arch itself will be used to determine arch deformation as well as a simple tape and offset determination of the arch profile.

Extensometer - An Irad Gage flexible sonic probe extensometer, recently certified as safe for use in Canadian underground coal mines will be used to determine strata movement up to 7.5 m from the gateroad. This will reveal the extent of the yield zone around the gateroad.

Pack Struts - Measurement of convergence in the pack must be determined by an instrument capable of being read from the gateroad and, since they are rarely recovered, such instruments must be simple, inexpensive and reliable.

The Pack Strut is of telescopic tubular steel construction with an electrical insert for measuring closure. From the bottom of the strut, a flexible cable runs to the roadway and an I.S. certified readout box allows determination of the closure.

Flat Jacks - consist of plate-like cell filled with oil or mercury and connected to a pressure transducer. Oil is delivered from a pump unit to the transducer, and when the cell pressure and pump pressure are equal, the transducer valve opens and the oil returns to the pump.

Installation

Instrumentation described above will be installed to the pattern shown in Fig. 2.

Strata bolts will be installed at the brushing face either between production shifts or over a weekend. Pack instrumentation will be installed in the pack adjacent to the bolt section during the following week.

Monitoring

Investigation sites will be monitored at a frequency governed by the proximity of the face, i.e., as the faceline advances further from the site, monitoring frequency will decrease. In addition to monitoring, some instrumentation maintenance and/or rehabilitation may be necessary depending on the degree of deformation of the roadway.

Geotechnical Evaluation of the Proximate Strata

It is particularly important that such an evaluation is included in this investigation as there is very little information of this type available for the Sydney coalfield.

A separate geotechnical evaluation will be carried out for each investigation site installed, in the following stages:

1) Diamond drilling of NX diameter (54 mm) cored boreholes to 15 m above and below the seam.
2) Logging of the cores on the basis of lithology, integrity, parting frequency, joint frequency, etc., and the allocation of specimens for testing.
3) Testing of specimens to obtain physical and mechanical properties data.
4) Geotechnical mapping of the mine opening.

Back Analysis

In order to provide more data for the comparison of gateroads, back analysis data collected recently in the coalfield will be used.

Data collection entailed the determination of the roadway profile at varying distances behind the coal face. The resulting data is being plotted on roadway paths and sections, which when combined with other production data (e.g., face advance rates, face stand locations, roadway rips and dints, changes in pillar widths) will allow the gross effects of these factors on roadway deformation to be determined.

Implementation

In order to derive the maximum amount of information from the study, it is proposed that two or three sites be installed in the 8E Maingate to determine the effects of mining and geological factors on pack behaviour. Additional sites would be installed in the 8E Returngate and other districts if required. It would be advantageous to install the pack instrumentation before tracer gas studies are carried out so that the pack behaviour can be related to the tracer gas results.

AIRFLOW INVESTIGATIONS

The airflow investigations are intended to identify the major air leakage paths from the intake gateroad through the gob and out into the return. These will then be correlated with localized geological features (e.g. sandstone channels).

Tracer gas techniques will be utilized to assess the effectiveness of roadside packs and sealants currently used and any new types used in the future. Analysis of these results together with the information gathered from the geotechnical investigations will indicate the optimum solution for sealing gateroads in the Sydney coalfield.

Pressure measurements made across the pack may also allow a "resistance value" to be assigned to each type.

INVESTIGATION METHODS

To accomplish the objectives the following experimentation will be performed:

At all geotechnical installations smoke tubes will be used to trace leakage of air into the gob.

Air can enter the gob either through the roadside pack or over the top of the pack through cracked and broken strata. Smoke tubes would provide a rough visual assessment of how air was entering the gob. This test would be repeated on a regular basis from the time of installation of the site until all appreciable ground movement in the vicinity had ceased.

For each working face to be investigated the quantity of air leaking from the intake gateroad would be measured. By releasing a known steady flow of tracer gas (SF_6) into the intake gateroad and measuring the concentration at the intake face end the quantity of air flowing at the release point can be calculated. Figure 3 shows how several such release points along the length of the intake would be utilized (R1 to R10). Samples would be collected at the intake face end (S1) and analyzed using gas chromatography on surface. By accurately determining the quantity of air flowing at each release point the volume of air entering the gob between adjacent release stations can be found.

A similar technique can be used in the return gateroad to determine where the leakage air reenters. In this case tracer gas would be released at a known steady flow rate from the return face end. Air samples would be taken at several locations along the return gateroad as shown in Fig. 4.

Air entering from the gob would dilute the general body concentrations of the tracer gas moving outbye along the return. Hence air quantities at each sampling location can be obtained from the concentration at that point.

The above experiments may reveal one or more major leakage paths through the gob associated with geological features. This would be confirmed by releasing tracer gas into the pack on the intake gateroad at the intersection with the feature. Air samples would then be taken at the appropriate locations in the return (see figure 5).

By comparing the tracer concentrations at locations S1, S2 and S3 the amount of leakage via the geological structure may be calculated.

Once the quantity of air leaking through a section of pack has been established a "resistance valve" may be determined by measuring the pressure across the pack. This will be done at each geotechnical installation by placing a small diameter thick walled tube through the pack during its construction (see figure 6). The pressure drop across the pack can then be measured directly by connecting this up to a magnehelic gauge. Comparison of this pressure drop with that across the district at this location will give an indication of the resistance to the passage of air provided by the pack with that of the gob/return gate hand stowed pack.

Equipment and Personnel Requirements

All materials and equipment used in the airflow study will be safe and approved for underground use. Air samples will be taken underground, but analyzed on surface, thus negating the need for any electrical apparatus to be taken underground.

For most parts of this study manpower requirements will be low and the personnel supplied by CBCRL. However, a large number of men may be required on one or more weekends (up to ten), this exceeds the resources of CBCRL and some support would be needed from CBDC (five men).

Implementation

It is important that the airflow investigations be carried out in conjunction with the geotechnical investigations. The geotechnical information may be gathered during the normal shifts during the week. However, it is intended that some airflow measurements be made on the weekend in order to eliminate the fluctuations inherently linked to the mining operation (e.g. opening and closing ventilation doors).

DISCUSSION

The investigations proposed here requires active, continuous and irreversible support from CBDC in order to justify their costs (approximately $20K per site; to be incurred by CBCRL). These costs reflect consumable items and subcontracted geotechnical evaluation of the strata only; no allowance has been made for manpower costs. Such expenditures necessitate a close working relationship and involvement between CBCRL and CBDC in order to realize the full potential of the investigations, and as a result it is suggested that this proposal be fully discussed at a meeting between CBDC and CBCRL, and that the following specific points be addressed and resolved:

1) Availability of Corporation manpower and equipment for installation drilling;
2) Availability of Corporation manpower for monitoring, including survey levelling of strata bolts;
3) Availability of Corporation manpower and equipment for cored borehole drilling at the investigation sites; and
4) Access and cooperation during airflow investigations.

When these areas have been finalized, it will then be necessary to select site locations and liaise at colliery level for their installation.

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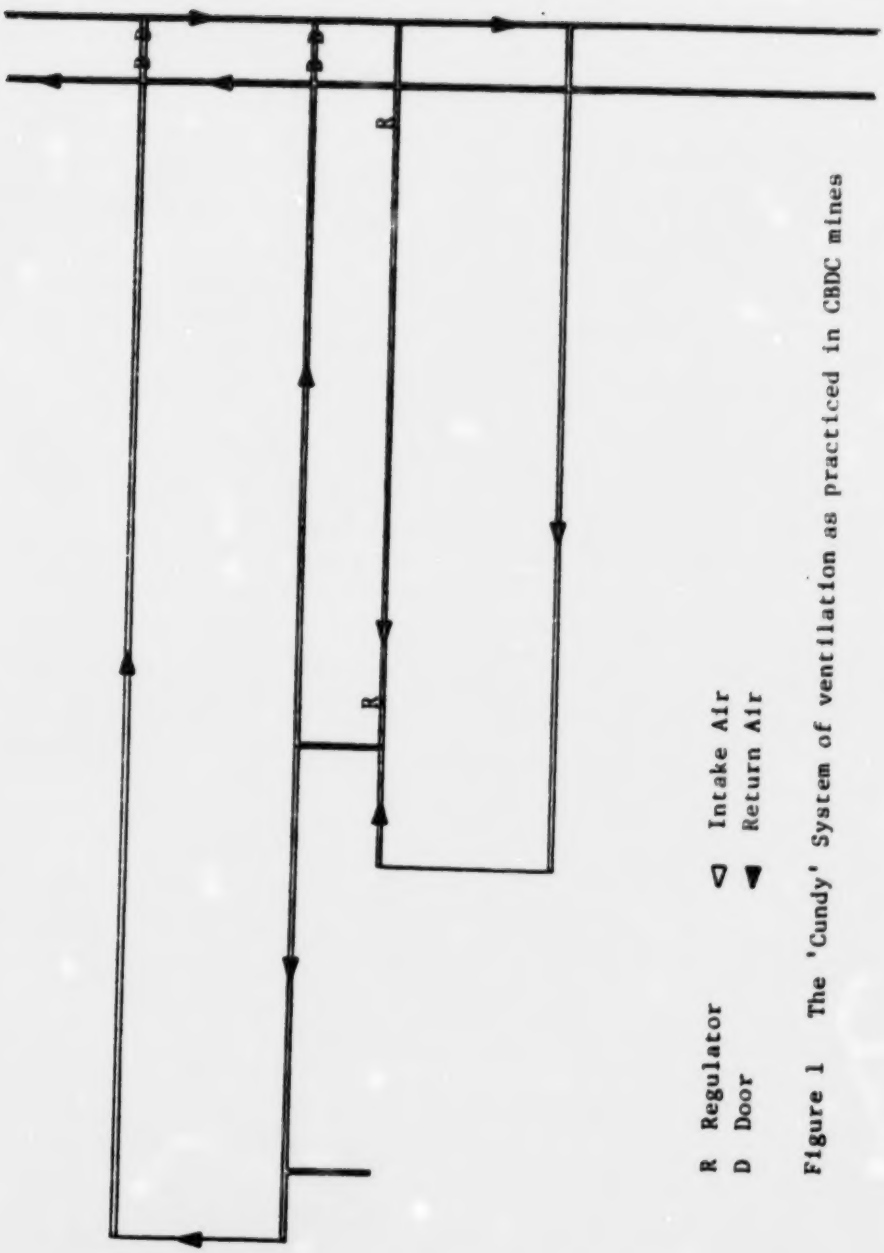
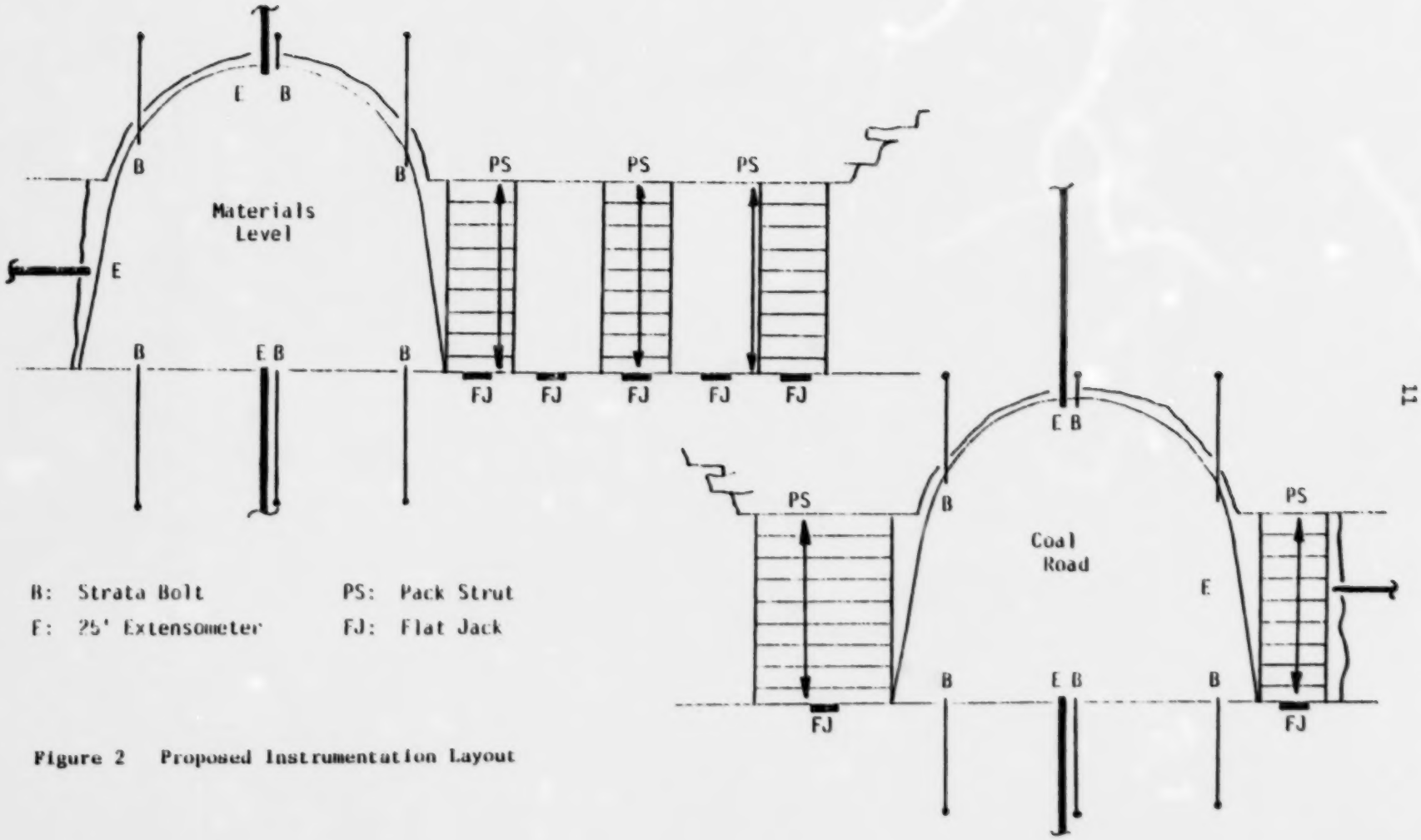


Figure 1 The 'Cundy' System of ventilation as practiced in CBDC mines



B: Strata Bolt PS: Pack Strut

E: 25' Extensometer FJ: Flat Jack

Figure 2 Proposed Instrumentation Layout

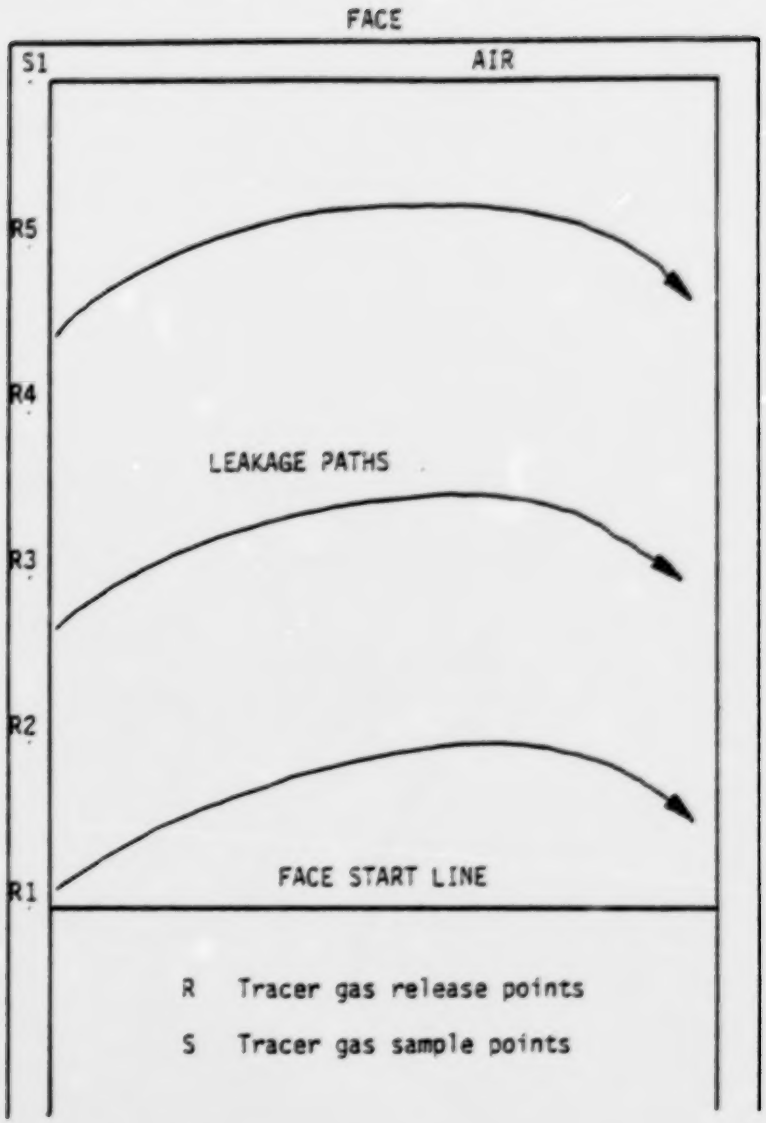


Figure 3 Experimental configuration for determination of air leakage from an intake gateroad

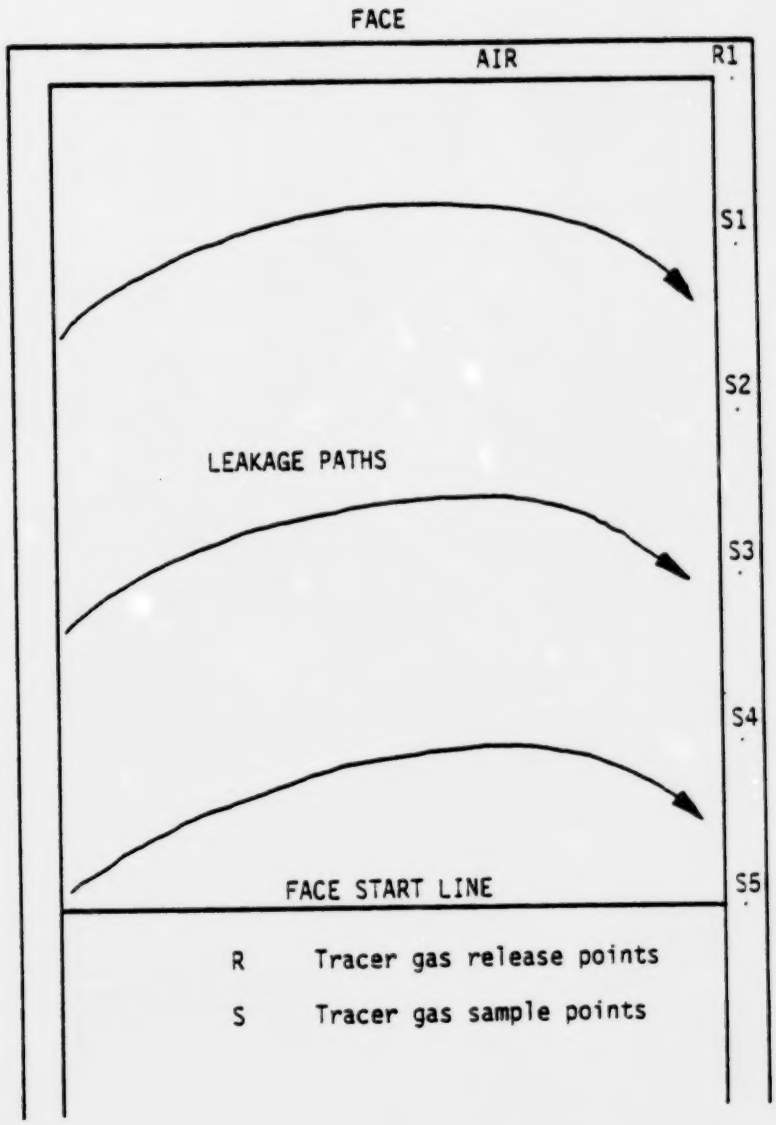


Figure 4 Experimental configuration for the determination of air reentering a return gateroad from the gob

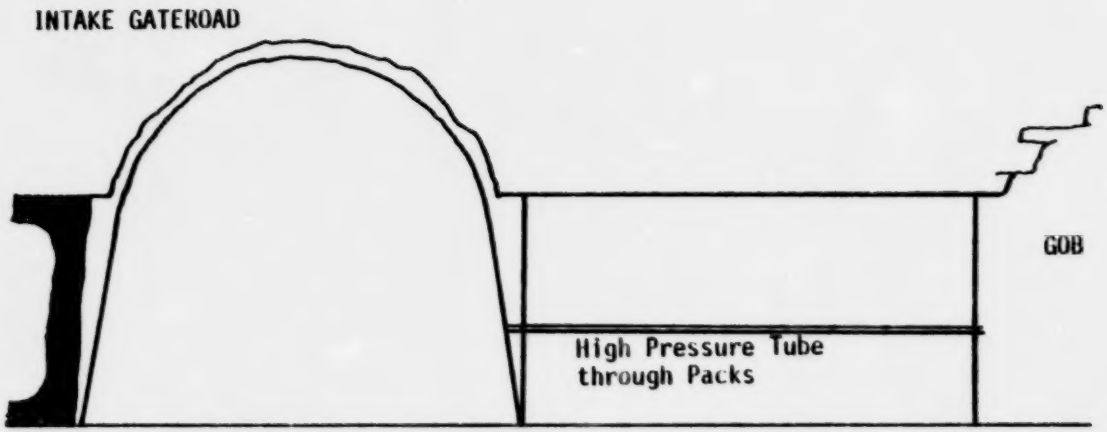


Figure 5 Location of pressure tubing through roadside packs

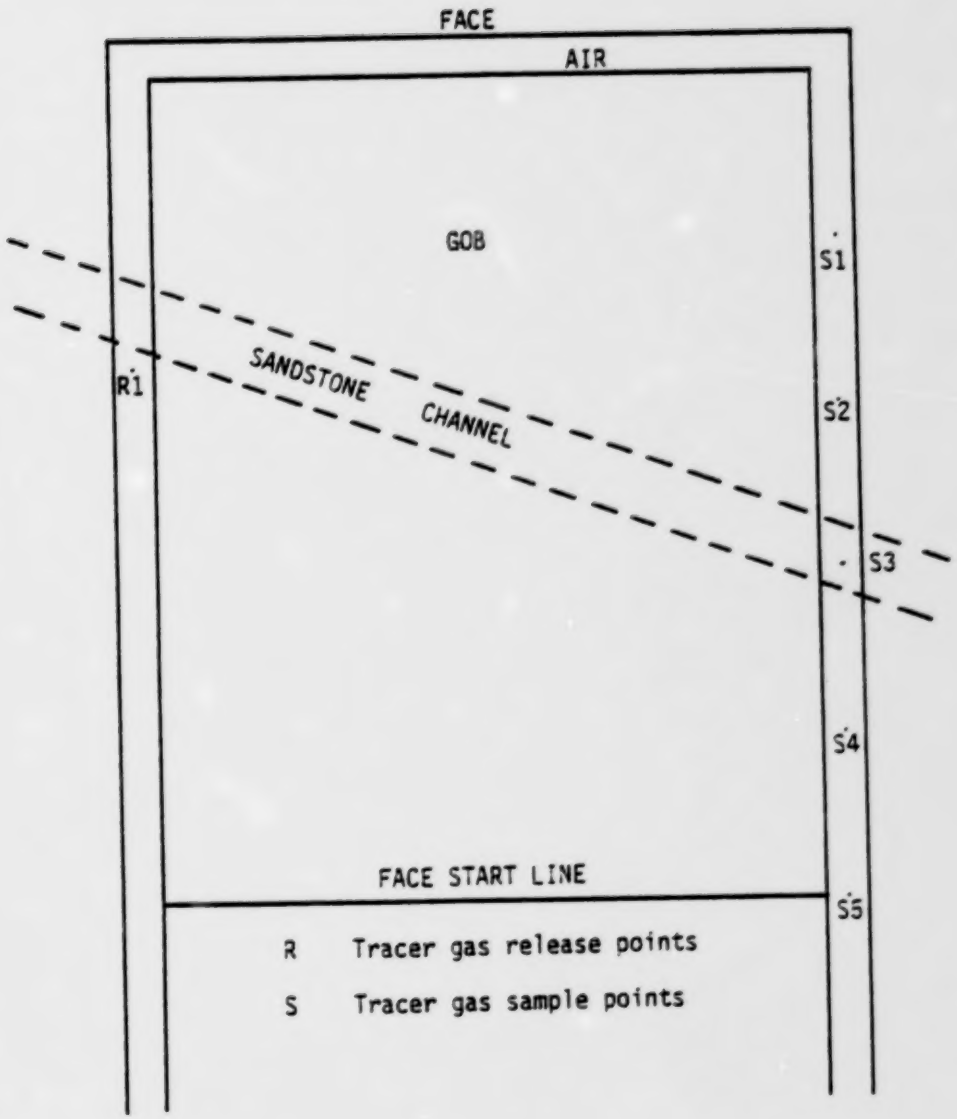


Figure 6 Experimental Configuration for the determination of the effect of sandstone channels on gob leakage